

# Exploring the Impact of Media Coverage and Limited Medical Resources on Influenza Transmission Dynamics: Insights from a Mathematical Modeling Study

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**Abstract.** Changes in personal protective behaviors driven by media influence contribute to epidemic prevention and control, whereas limited medical resources constrain the effectiveness of such interventions. In this study, we propose a novel influenza transmission model with the media impact and limited medical resources. Theoretical and numerical analyses reveal some complex nonlinear dynamics, including saddle node bifurcations, forward and backward bifurcations, and both subcritical and supercritical Hopf bifurcations. Besides, two types of bistable scenarios are identified: bistability of a disease-free equilibrium and an endemic equilibrium, and bistability of two different endemic equilibria. In addition, we fit the model to the monthly new influenza reported case data from August 2023 to October 2024 in Jiangsu, China, where the fitting results successfully capture the observed epidemic trends. The estimated basic reproduction number  $\mathcal{R}_0 = 1.2183 > 1$  implies sustained transmission. Finally, sensitivity analysis suggests that effectively controlling influenza transmission can be achieved by decreasing the population input rate, transmission rate, awareness loss rate, and medical saturation constant, as well as increasing the awareness transmission rate, media response intensity, and maximum recovery rate. These findings highlight the critical role of combining public awareness initiatives with enhanced medical resource allocation to strengthen influenza prevention and control efforts.

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## 1 Introduction

Influenza is an acute respiratory infectious disease caused by influenza virus, and is one of the most contagious diseases in respiratory infections. There are four types of influenza viruses: A, B, C and D, with types A and B responsible for seasonal epidemics [19]. According to the World Health Organization (WHO), seasonal influenza leads to approximately one billion infections globally each year, including 3-5 million cases of severe illness and 290,000 to 650,000 respiratory-related deaths annually [44]. Influenza symptoms typically appear about two days after exposure to the virus and include sudden onset of fever, dry cough, headache, muscle and joint pain, severe malaise, sore throat, and runny nose. The cough may be severe and persist for two weeks or longer. While most individuals recover within a week without medical intervention, influenza can lead to severe illness or death, particularly in high-risk populations. It may also exacerbate existing chronic conditions and, in severe cases, progress to pneumonia or sepsis [44]. Beyond its impact on individual health, influenza significantly affects social and economic systems. Therefore, understanding the transmission dynamics, epidemic trends, and control strategies of influenza through mathematical modeling holds both theoretical significance and practical relevance [8,31].

During influenza outbreaks, media serves as a source of information for the public to understand the dangers of influenza transmission, prompting people to adopt self-protective behaviors such as social distancing, wearing masks, and avoiding gathering in response to the spread of influenza virus. Simultaneously, it serves as a warning to individuals to minimize unnecessary interactions with others and decrease the transmission rate. Thus, media coverage can greatly impact the spread of infectious diseases [9,16,28,38]. Some scholars also study the media's role in encouraging people to get vaccinated [24], encouraging preventive treatment of tuberculosis (TB) [48], and encouraging drug-sensitive TB patients to standardize treatment to avoid developing drug resistance [47]. Due to the high transmissibility of influenza, an outbreak can quickly lead to widespread infections. The adequacy of medical resources plays a critical role in response and control efforts, while resource limitations can significantly undermine the effectiveness of these measures [3,50]. Studying the transmission dynamics of epidemics under the joint influence of these two factors has aroused research interest [17].

Mathematical modeling has become a vital tool for quantifying and understanding the influence of media coverage on the transmission and control of infectious diseases. The main work at present is to study the impact of the media on the transmission rate [6,10,29,30,36,45,46], that is, the media encourages people to take measures such as wearing masks and maintaining social distancing to reduce the possibility of infection. In this regard, there are some main media response functions to characterize the media impact on the spread of infectious diseases. Cui *et al.* [10] proposed an Susceptible-Exposed-Infectious (SEI) model with a media-modulated transmission rate  $\beta(I) = \beta e^{-mI}$ , where  $S, E$  and  $I$  represent the susceptible, exposed and infectious populations respectively, while  $\beta$  denotes the maximum transmission rate, and  $m$  quantifies the influence of